

**Erin H. Lay**  
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## EDUCATION

Ph.D., Physics, University of Washington, 2008  
M.S., Physics, University of Washington, 2003  
B.A., Physics, Grinnell College, 2002

## RESEARCH POSITIONS

Research Scientist at Los Alamos National Laboratory in the Space and Remote Sensing Group (ISR-2):  
*Aug. 2010-present*

Post-doc at Los Alamos National Laboratory in ISR-2: *Aug. 2008 – Aug. 2010*

Graduate research assistant in Dept. of Earth and Space Sciences, University of Washington: *March 2003 – Aug. 2008*

## GRANTS

*Validation of lightning-to-ionosphere coupling model by remote sensing of naturally occurring sources,*  
Post-doctoral Mini-Grant, Los Alamos National Laboratory, Institute of Geophysics and Planetary Physics, 2009-2010

*Understanding thunderstorm effects on the ionosphere: a new approach to investigate possible convective and electrical coupling mechanisms,* Laboratory Directed Research and Development Exploratory Research Grant, Los Alamos National Laboratory, 2010-*present*

*From Troposphere to Ionosphere: How Much do Thunderstorms Disturb the Total Electron Distribution?,* Early Career Research Grant: Laboratory Directed Research and Development, Los Alamos National Laboratory, 2013-*present*

## RESEARCH PROJECTS

- Probing ionospheric response to thunderstorms by using broadband lightning waveforms and ionospheric total electron content measurements (*2009-present*).
- Investigating the relationship of narrow bipolar events to severe weather using NEXRAD radar and Los Alamos Sferic Array databases (*2008-present*).
- Extracting total ionospheric content from impulsive, broadband sources such as the Los Alamos Portable Pulser and lightning strokes detected by the FORTE satellite (*2008-present*).
- Data analysis and modeling of lightning energy propagation and effects in the Earth-Ionosphere system (*2006-present*).
- Calibration and validation of the World Wide Lightning Location Network (*2003-2008*).
- Building, testing, and launching x-ray detectors for the Miniature Spectrometer (MINIS) Balloon Campaign (*2003-2005*).

## TEACHING

Teaching Assistant

- Access to Space Class (*Spring 2004, 2005, 2006*, UW Department of Earth and Space Science): Group mentor for 3-5 students who had to design and build a scientific data collection instrument to fly on a stratospheric balloon by the end of the academic quarter.
- Introduction to Space Physics (*Fall 2003*, UW Department of Earth and Space Science): Taught demonstration laboratory sections, leading students through basic electricity and magnetism experiments.

- Introductory Physics Lab: Electricity and Magnetism, *Winter 2002*; Optics and Waves, *Winter 2003*, UW Department of Physics.
- Introductory Physics Tutorials (problem sessions to complement traditional lectures): Mechanics, *Fall 2002*; Electricity and Magnetism, *Winter 2003*, UW Department of Physics.
- Workshop Physics classes (2001-2002, Grinnell College Department of Physics)
- Introduction to Chemistry Lab (1999-2000, Grinnell College Department of Chemistry)

#### Mentor/Tutor

- Mentor for Undergraduate Summer Research Student (*Summer 2005*, UW Department of Earth and Space Science): Guided female undergraduate in building and testing lightning detection stations and analyzing data by writing and using MATLAB programs.
- Graduate Student Mentor (2003-2004, UW Dept. of Physics): provided mentorship to four first-year (2 female, 2 male) graduate students. Worked in collaboration with their academic advisor, Dr. Stephen Sharpe.
- Tutor in UW Physics Study Center (2002-2003, UW Dept. of Physics): Helped students work through introductory physics homework problems.
- Tutor for Introductory Physics student (*Fall 2001*, Grinnell College Department of Physics)

#### PUBLICATIONS

- Lay, E. H.**, X.-M. Shao, A.R. Jacobson (2014), D region electron profiles observed with substantial spatial and temporal change near thunderstorms, *J. of Geophys. Res.*, 119, doi:10.1002/2013JA019430.
- Lay, E. H.**, X.-M. Shao, C.S. Carrano (2013), Variation in total electron content above large thunderstorms, *Geophys. Res. Lett.*, 40, 1-5, doi:10.1002/grl.50499.
- Shao, X.-M., **E. H. Lay**, and A. R. Jacobson (2013), Reduction of electron density in the night-time lower ionosphere in response to a thunderstorm, *Nature Geoscience*, 6, 29-33, DOI:10.1038/NGEO1668.
- Jacobson, A. R., X.-M. Shao, and **E. H. Lay** (2012) Time-domain waveform, and azimuth variation, of ionospherically reflected VLF/LF radio emissions from lightning, *Radio Sci.*, 47, RS4001, doi:10.1029/2012RS004980.
- Shao, X-M., **E. H. Lay**, A. R. Jacobson (2012), On the Behavior of Return Stroke Current and the Remotely Detected Electric Field Change Waveform, *J. Geophys. Res.*, 117, D07105, doi:10.1029/2011JD017210.
- Lay, E. H.** and X.-M. Shao (2011), Multi-station probing of thunderstorm-generated D-layer fluctuations by using time-domain lightning waveforms, *Geophys. Res. Lett.*, 38, L23806, doi:10.1029/2011GL049790.
- Lay, E. H.** and X.-M. Shao (2011), High temporal and spatial-resolution detection of D-layer fluctuations by using time-domain lightning waveforms, *J. Geophys. Res.*, 116, A01317, doi:10.1029/2010JA016018.
- Lay, E. H.**, S. Close, P. Colesstock, A. R. Jacobson, G. Bust (2011), Development and error analysis of nonlinear ionospheric removal algorithm for ionospheric electron density determination using broadband RF data, *J. Geophys. Res.*, 116, A02316, doi:10.1029/2010JA015862.
- Lay, E. H.**, C. J. Rodger, R. H. Holzworth, M. Cho, and J. N. Thomas (2010), Temporal-spatial modeling of non-linear electron density enhancement due to successive lightning strokes, *J. Geophys. Res.*, 115, A00E59, doi:10.1029/2009JA014756.
- Smith, D. M., B. J. Hazelton, B. W. Grefenstette, J. R. Dwyer, R. H. Holzworth, and **E. H. Lay** (2010), Terrestrial gamma ray flashes correlated to storm phase and tropopause height, *J. Geophys. Res.*, 115, A00E49, doi:10.1029/2009JA014853.
- Rodger, C. J., J. B. Brundell, R. H. Holzworth, and **E. H. Lay** (2009), Growing Detection Efficiency of the World Wide Lightning Location Network, *AIP Conf. Proc.* 1118, pp. 15-20;

- doi:<http://dx.doi.org/10.1063/1.3137706>.
- Hazelton, B. J., B. W. Grefenstette, D. M. Smith, J. R. Dwyer, X.-M. Shao, S. A. Cummer, T. Chronis, **E. H. Lay**, and R. H. Holzworth (2009), Spectral dependence of terrestrial gamma-ray flashes on source distance, *Geophys. Res. Lett.*, 36, L01108, doi: 10.1029/2008GL035906.
- Thomas, J. N., B. H. Barnum, **E. Lay**, R. H. Holzworth, M. Cho, and M. C. Kelley (2008), Lightning-driven electric fields measured in the lower ionosphere: Implications for transient luminous events, *J. Geophys. Res.*, 113, A12306, doi:10.1029/ 2008JA013567.
- Kokorowski, M., et. al (2008), Magnetospheric electric field variations caused by storm-time shock fronts, *Adv. in Space Res.*, 42(1).
- Dowden, R. L., et al. (2008), World-wide lightning location using VLF propagation in the earth-ionosphere waveguide, *IEEE Ant. and Prop. Mag.*, 50(5).
- Lay, E. H.**, A. R. Jacobson, R. H. Holzworth, C. J. Rodger, and R. L. Dowden (2007), Local time variation in land/ocean lightning flash density as measured by the World Wide Lightning Location Network, *J. Geophys. Res.*, 112, D13111, doi: 10.1029/ 2006JD007944.
- Jacobson, A.R., R. Holzworth, **E. Lay**, M. Heavner, and D. A. Smith (2007), Low-frequency ionospheric sounding with Narrow Bipolar Event lightning radio emissions: regular variabilities and solar-X-ray responses, *Annales Geophys.*, 25, 2175– 2184.
- Rodger, C. J., S. W. Werner, J. B. Brundell, N. R. Thomson, **E. H. Lay**, R. H. Holzworth, and R. L. Dowden (2006), Detection efficiency of the VLF World-Wide Lightning Location Network (WWLLN): Initial case study, *Annales Geophys.*, 24, 3197-3214.
- Jacobson, A.R., R. Holzworth, J. Harlin, R. Dowden, and **E. Lay** (2006), Performance assessment of the World Wide Lightning Location Network (WWLLN) using the Los Alamos Sferic Array (LASA) as ground truth, *J. Atmos. and Oceanic Technology*, 23, 1082-1092.
- Kokorowski, M., et al. (2006), Rapid fluctuations of stratospheric electric field following a solar energetic particle event, *Geophys. Res. Lett.*, 33, L20105, doi:10.1029/ 2006GL027718.
- Holzworth, R. H. et al. (2005), Balloon observations of temporal variation in the global circuit compared to global lightning activity, *Adv. in Space Res.*, 36, 2223-2228.
- Lay, E. H.**, R.H. Holzworth, C.J. Rodger, J.N. Thomas, O. Pinto, Jr., and R.L. Dowden (2004), WWLL Global Lightning Detection System: Regional Validation Study in Brazil, *Geophys. Res. Lett.*, 31, L03102, doi: 10.1029/2003 GL018882.
- Lay, E. H.**, A. Kirakosian, J. L. Lin, D. Y. Petrovykh, J. N. Crain, F. J. Himpel, R. R. Shah, and N. L. Abbott (2000), Alignment of Liquid Crystals on Stepped and Passivated Silicon Templates Prepared in Ultrahigh Vacuum, *Langmuir*, 16 (16), 6731-6738.

## PRESENTATIONS

- Lay, E. H.**, X-M. Shao, A.R. Jacobson (2013), D-layer electron profiles observed with substantial spatial and temporal change near thunderstorms, Abstract AE33A-0318, presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
- Lay, E. H.**, X.-M. Shao, C.S. Carrano, and A.R. Jacobson (2013), Thunderstorm-induced fluctuations detected in ionospheric plasma, *CEDAR Meeting*, Boulder, CO, 22-28 June.
- Lay, E. H.**, X-M. Shao, A.R. Jacobson (2012), Electrical modification of D-layer electron distribution by local thunderstorm, Abstract AE41A-05, presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.
- Lay, E. H.**, X-M. Shao, A.R. Jacobson (2012), High temporal and spatial-resolution detection of atmospheric gravity wave effects on D-layer electron density, *CEDAR Meeting*, Santa Fe, NM, 24-29 June.
- Lay, E. H.**, X-M. Shao, (2011), D-layer fluctuations directly above a thunderstorm region detected by using time-domain LF/VLF waveforms, Abstract AE21A-0222 presented at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Lay, E. H.**, X-M. Shao, (2011), Understanding thunderstorm effects on the D-layer by using time-domain

- lightning waveforms, *International Conference on Atmospheric Electricity*, Rio de Janeiro, Brazil.
- Lay, E. H.**, X-M. Shao, (2010), High temporal and spatial-resolution detection of D-layer fluctuations using time-domain lightning waveforms, Abstract AE21B-0269 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Lay, E. H.**, X-M. Shao, (Invited, 2010), Detection of D-layer perturbations with high time and spatial resolution, *CEDAR Meeting*, Boulder, CO.
- Lay, E. H.**, X-M. Shao, A. R. Jacobson (2009), Regional probing of ionospheric perturbations within 500 km of a lightning storm by using LASA VLF/LF broadband waveforms, *EOS Trans. AGU*, 90(52), Fall Meet. Suppl., Abstract AE41B-03.
- Suszczynsky, D.M and **E. H. Lay (presenter)** (2009), Case Study of a Strong Narrow-Bipolar-Event-Producing Storm on July 2 - 3, 2005, *EOS Trans. AGU*, 90(52), Fall Meet. Suppl., Abstract AE43B-0278.
- Lay, E. H.**, C. J. Rodger, R. H. Holzworth, M. Cho, and J. N. Thomas (Invited, 2009), Temporal-spatial modeling of non-linear electron density enhancement due to successive lightning strokes, *WWLLN Standing Committee Meeting*, Seattle, WA.
- Lay, E. H.**, C. J. Rodger, R. H. Holzworth, A. R. Jacobson, J. N. Thomas, and J. B. Brundell (Invited, 2009), World-Wide Lightning Location Network: Improvements in global detection efficiency and estimated stroke energy, *WWLLN Standing Committee Meeting*, Seattle, WA.
- Lay, E. H.**, S. Close, G. Bust, and A. Jacobson (2009), Non-linear retrieval of ionospheric total electron content (TEC) using FORTE broadband data, *AGU Chapman Conf. on the Effects of Thunderstorms and Lightning on the Upper Atmos.*, State College, PA.
- Lay, E. H.**, S. Close, G. Bust, and A. Jacobson (Invited, 2009), Non-linear retrieval of ionospheric electron density using FORTE broadband data, Stanford University.
- Lay, E. H.**, C. J. Rodger , R. H. Holzworth, A. R. Jacobson, D. M. Suszczynsky, J. N. Thomas, and J. B. Brundell (2009), World-Wide Lightning Location Network: improvements in global detection efficiency and estimated stroke energy, *Fourth Conf. on Met. Appl. of Lightning Data*, 89<sup>th</sup> Meet. Amer. Met. Soc., Phoenix, AZ.
- Lay, E.H.**, R.H. Holzworth, M. Cho, C.J. Rodger, and J.N. Thomas (2008), Temporal-spatial modeling of non-linear electron density enhancement due to successive lightning strokes, *Eos Trans. AGU*, 89(53), AGU Fall Meet. Suppl., Abstract AE13A-0299.
- Lay, E. H.** (Invited, 2008), World-Wide Lightning Location Network: Investigating global energetic effects of lightning, Grinnell College.
- Lay, E. H.** (Invited, 2008), World-Wide Lightning Location Network: Development and applications, Los Alamos National Laboratory.
- Lay, E.H.**, R.H. Holzworth, M. Cho, and J.N. Thomas (2007), Global modeling of D-region electron density enhancements from lightning, *International Conference on Atmospheric Electricity*, Beijing, China.
- Lay, E.H.**, R.H. Holzworth, A.R. Jacobson, C.J. Rodger, H.U. Frey, and R.L. Dowden (2007), World Wide Lightning Location Network: strong lightning under the nighttime ionosphere, *International Union of Geodesy and Geophys.*, Perugia, Italy, oral presentation.
- Lay, E.H.**, R.H. Holzworth, H.U. Frey, C.J. Rodger, and R.L. Dowden (2006), Using the World Wide Lightning Location Network to provide insight on elves detected by ISUAL, *EOS, Trans. AGU*, 87(52) Fall Meet. Suppl., Abstract AE51A-0269.
- Lay, E.H.**, A.R. Jacobson, R.H. Holzworth, C.J. Rodger, and R.L. Dowden (2006), Implications for Ionospheric Electron Densities from Local Time Variation in Lightning Activity as Measured by the World Wide Lightning Location Network, *poster, CEDAR Workshop*, Santa Fe, NM.
- Lay, E. H.**, A. R. Jacobson, and R.H. Holzworth (2005), Land/Ocean Differences Between FORTE Optical and Ground-based VLF Lightning Detection, *EOS, Trans. AGU*, 86(52) Fall Meet. Suppl., Abstract AE21A-0980.
- Lay, E. H.**, Holzworth, R. H., Rodger, C. J., Jacobson, A. R., Lopez, L., Smith, D. (2005), Using WWLLN to Provide Insight on Terrestrial Gamma Ray Flashes, *poster, CEDAR Workshop*, Santa Fe,

NM.

- Lay, E. H.**, C. J. Rodger, R. H. Holzworth, and R. L. Dowden (Invited, 2005), Introduction to World-Wide Lightning Location Network (WWLLN), *General Assembly of the European Geophys. Union*, EGU05-A-02875, Vienna.
- Lay, E. H.**, Jacobson, A. R., Holzworth, R. H. (2004), Comparison of World Wide Lightning Location Network and FORTE Lightning Data, *EOS, Trans. AGU*, 85(47) Fall Meet. Suppl., Abstract AE33A-0175.
- Lay, E. H.**, C. J. Rodger, R. H. Holzworth, and R. L. Dowden (Invited, 2004), World-Wide Lightning Location Network, *Global Seismographic Network Standing Committee Meeting*, Albuquerque, NM.
- Lay, E. H.**, Holzworth, R. H., Rodger, C. J., Thomas, J. N., Pinto Jr., O., Dowden, R. L. (2003), WWLL Global Lightning Detection System: Regional Validation Study in Brazil and USA, *EOS, Trans. AGU*, 84(46) Fall Meet. Suppl., Abstract AE22A-1111.

## SERVICE

- World-Wide Lightning Location Network (WWLLN) Management Team (*2008-present*)
- Peer review of external journal articles (*J. of Geophys. Rev., Radio Sci.*) (*2006-present*)
- Expanding Your Horizons Volunteer – Girls’ gateway to STEM (*2013-present*)
- Judge for poster competitions
  - Los Alamos National Laboratory Post-doc Day (*Spring 2013*)
  - American Geophysical Union Outstanding Student Poster Competition (*Dec 2012*)
- Senator in Univ. of WA Graduate and Professional Student Senate (*2004-2005*)
- President of Physics Graduate Student Council, Univ. of WA (*2003-2004*)

## HONORS AND AWARDS

- Los Alamos National Laboratory SPOT Award for supporting the laboratory mission, 2013.  
Grinnell College Alumni Scholar, 2008  
Honorable Mention, Poster Competition, AGU Fall Meeting, 2006  
Honorable Mention, Poster Competition, CEDAR workshop, 2005  
Karrer Prize, Dept. of Physics, University of Washington, 2004  
Phi Beta Kappa, 2002  
Barry Goldwater Scholarship, 2001  
Trustee Honor Scholarship, Grinnell College, 1998-2002